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UTILIZATION OF COMPONENTS FROM MOTHBALLED GENERATING STATION

Report No 84-87-K

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ABSTRACT

The Operations Research Department was asked by Central Thermal Services to assist in the development of policies for the utilization of components from mothballed thermal generating stations. The study focussed on Lennox GS but the results are applicable to mothballed thermal generating facilities in general. The report lays out a strategy and guidelines for setting up and implementing policies and procedures for the utilization of components for mothballed generating stations.

job	file	date	report no.
740671-131-501	809.307	April 18, 1984	84-87-K

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EXECUTIVE SUMMARY

UTILIZATION OF COMPONENTS FROM MOTHBALLED GENERATING STATION

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The Operations Research Department performed a study to assist the establishment of policies and procedures for the utilization of components from mothballed thermal generating stations. For practical purposes, the study confined itself with the facilities at Lennox GS. The results presented here can be applied to other mothballed facilities, presently and in the future.

The study examined requests for components and identified the need for examining station requirements. The methods for handling component requests were examined with emphasis on:

- the decision-making procedure;
- information required to make the decision;
- where records of the transaction should be stored;
- what are the trade-offs involved?

The study recommends a two-part decision-making procedure: the Planning Model and the Decision Model.

The Planning Model of the study examines the future requirements for Lennox. Factors that would lead to the demothballing and recommissioning of the station were identified. The available time and the time required to do this were also examined. Two time horizons were considered: the next five years and a longer twenty-year horizon; the first requires input from PSOD and the latter from System Planning Division. The outcome of the Planning Model is a set of station capabilities that are required in these time frames.[1]

[1] Based on the long and short-term BES generation plans.

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The Decision Model deals with the evaluation of component requests. The goals are to set up criteria and a method of evaluation, that satisfy desired station capabilities as well as capitalize on the benefits of releasing components.

To assist in implementing the models, procedures are proposed to deal with component requests.

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To Mr. T.J. Popiel
Group Manager,
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UTILIZATION OF COMPONENTS FROM MOTHBALLED GENERATING STATIONS

1. INTRODUCTION

Since the mothballing of Lennox Generating Station, there have been numerous requests for its components. Decision makers evaluating these requests have the responsibility to maintain the state of the station so as to allow it to return to service at some future date, at a reasonable cost and with reasonable lead time. At the same time, there have been increasing pressures to reduce costs through utilization of this capital equipment.

To deal with the two conflicting issues, it is necessary to determine to what extent facilities should be protected from scavenging. A method to evaluate the impact of a component's release is important to the request assessment. Once it has been determined that a component may be released, the costs and benefits can be assessed to decide whether it is preferable to do so.

1.1 Policy Objectives

This study is intended to establish guidelines and a methodology to assist in setting up a policy for the utilization of components at mothballed generating facilities. The future policy has the following objectives:

1. Provide guidelines for the development of a method to identify major components in each of the units at Lennox GS and to assess their criticality (ie, is the unit derated or shutdown as a result of component availability?).

2. Identify factors that would lead to demothballing and recommissioning of Lennox GS and the available lead time.

3. Identify alternatives for the utilization of mothballed equipment.

4. Set up procedure to deal with component requests.

5. Develop a method to assess the costs and benefits of the preferred alternatives.

6. Develop a method to ensure that component releases benefit the corporation as a whole.

1.2 Present Organization for Dealing With Requests for Mothballed Components

These operations have been examined with respect to:

1. Lines of Authority

2. Request Handling

1.2.1 Lines of Authority

To represent the interests of the mothballed stations, CTS has a section within the Chemistry and Metallurgy Department devoted to mothballed facilities. Requests and issues regarding mothballed facilities are referred to the Manager of Chemistry and Metallurgy but many are directed to the Equipment and Reliability Department or to the station manager. During mothballing, the station manager retains responsibility for station stores and capital equipment. Many component requests are made and approved during mothballing.

1.2.2 Request Handling

Requests for mothballed components are presently made at the managerial level. There are as yet no formal guidelines as to what information should be included in the request. The information contained in them varies from a simple request (the usual) to more detailed information including benefits, costs, reasons for the request, data needed, etc. Other useful information not often provided is:

- Cost saving resulting from granting the request.

- File numbers for identification

- Charge number for labour, transport and administration if the request is granted.

2. NEED FOR DEMOTHBALLING

The mothballed units of Lennox TGS may be required to be recommissioned under either one of the following two conditions:

1. Load growth as forecast or higher for the 1990's.

2. Emergency resulting from a major failure causing a prolonged loss of generation.

Normally, the reserve margin requirement for generation system operation is approximately 25% of planning firm load/1/. In the event of a severe contingency in the generation system, the reserve margin may fall short of this requirement, thus creating a need for the service of mothballed units.

The time required for recommissioning of mothballed units of Lennox TGS is dependent on the length of time the unit/station has been in the mothballed state. Such factors as general deterioration, staff availability, staff familiarity with equipment, component availability, and the adequacy of storage/preservation techniques will all be affected by the duration of mothballing.

2.1 Forecast Reserve Margin

Assuming the absence of severe contingencies in the generation system, the reserve margin has been calculated for the peak month (January) in the years from 1985 to 1993. The following formula is used for calculating the reserve margin:

Reserve Margin (MW) = [Total In-Service Capacity (MW)]
- [Planning Firm Load (MW)]

Where Total In-Service Capacity (MW)
= [Total System Capacity (MW)]
- [Total Mothballed and Retired Capacity (MW)]

Based on data available in September 1983/2,3/, the reserve margins for the years 1985 to 1993 are given in Table 1. The reserve margins for these years are well above the 25% requirement.

2.2 Energy Security Considerations

The energy security policy for the BES/1,4/ states that measures should be taken to ensure a negligible risk of severe energy shortfalls. Severe energy shortfalls are those which:

1. exceed 20% of energy demand, and

2. last more than four weeks.

The risk is considered to be negligible if such shortfalls are forecast to happen less than once in one hundred years.

Energy security will be affected by severe energy contingencies. Such contingencies may result from multiple generating unit failures which can be attributed to common-cause failures, failures affecting all units in an entire station or site, or failures which require the shutdown of similar units for safety reasons. The probability of losing a significant proportion of hydraulic or fossil generation for an extended period is negligible, and such scenarios are not considered in this study. However, the loss of a substantial proportion of nuclear generation may not be a negligible event. The following nuclear scenarios are considered in this study:

S_1: Loss of Pickering 'A' Station
S_2: Loss of Pickering 'B' Station
S_3: Loss of Bruce 'A' Station
S_4: Loss of Bruce 'B' Station
S_5: Loss of Darlington 'A' Station
S_6: Loss of Pickering 'A' and 'B' Units
S_7: Loss of 50% of all nuclear generation

The associated frequencies and durations of occurrence of these scenarios are not known. Estimates based on engineering judgment are available/5,6/ and tabulated in Table 2. The estimated frequency of S_6 is 1 in 1000 years and therefore, it requires no further consideration. Strikes with consequences like S_7 are unlikely to last for 6 months without government action.

The other scenarios (S_1 to S_5) have forecast frequencies higher than the critical value of 1 in 100 years (the overall forecast value for one of the three failure conditions to occur is 1 in 18 years), and also, their average durations are longer than that stipulated by the energy security policy. However, the occurrence of any one of them is not expected to cause energy shortfall greater than 20% of the energy demand. Hence, the energy security will not be violated by any of the energy contingencies under consideration.

TABLE 1

PEAK LOAD AND CAPACITY
IN JANUARY OF THE YEAR

	1985	1986	1987	1988	1989	1990	1991	1992	1993
*Total System Capacity (MW)	27 532	28 582	30 157	30 157	31 038	31 919	31 919	32 800	33 681
**Total Mothballed and Retired Capacity	4 146	4 714	5 108	5 108	5 108	5 108	5 108	5 108	5 108
Total In-Service Capacity (MW)	23 386	23 868	25 049	25 049	25 930	26 811	26 811	27 692	28 573
***Planning Firm Load (MW)	18 269	18 709	19 103	19 296	19 501	19 759	20 138	20 448	20 898
Reserve Margin (MW)	5 117	5 159	5 946	5 753	6 429	7 052	6 673	7 244	7 675
$\frac{\text{Reserve Margin}}{\text{Planning Firm Load}} \times 100\%$	28%	28%	31%	30%	33%	36%	33%	35%	37%

This table is based on information supplied by System Planning Division during the Study.

* Based on Table T-1 of Reference /2/

** Includes mothballing of Lakeview Units 3,4,5, and 6 which are not considered in Reference /2/

*** Based on Table 4 of Reference /3/

TABLE 2

NUCLEAR SCENARIOS AND ESTIMATED FREQUENCY OF OCCURRENCES

Scenarios	Duration (approximate)	Rationale	Frequency
S_1, S_2, S_3, S_4 or S_5	1 month	Small loss of coolant accident plus fission release. Requires manual use of vacuum building.	1 in 25 years*
	6 months	Energetic release plus fission products; service water/common facilities.	1 in 100 years*
	3 years	Problems relating to pressure tubes, ECI coolant tanks, vacuum building/service facilities and tunnels; boiler tube problems	1 in 200 years*
S_6	1 year	Considerable release of fission products such that the time for clean-up, decontamination and recommissioning of shared safety systems is lengthy. Common containment building. Closeness of Pickering 'A' and 'B' stations.	1 in 1000 years**
S_7	6 months	Operations strike with management operation of some stations.	1 in 20 years*

* Based on Reference /5/
** Based on Reference /6/

2.3 Reserve Margin Considerations

Reserve margins have been determined under each of the above scenarios. The results are given in Table 3. They show that the loss of a nuclear station may lower the reserve margin to less than the required 25% of the planning firm load for one month or longer. In such events, electricity imports and/or recommissioning of mothballed stations may be required to restore the integrity of the generation system. It may be noted that an x% reduction in reserve margin does not result in x% loss of load in the most likely cases where the margin was positive at the outset. Also, since the reserve margin is computed for the annual peak, the situation is much better at other times.

2.4 Summary

The above study on the impact of generation system contingencies on the reserve margin shows that the energy security policy is not likely to be violated by the occurrence of any one of the scenarios considered. However, the resulting lower reserve margins may require the recommissioning of mothballed units to restore reliability and integrity to the generation system.

3. PROPOSED METHODOLOGY

The study has been divided into two stages. The first looks at Lennox GS as a whole and the likely demands for a return to service in the next five years and in the next twenty years/3,7/. These considerations have been grouped as the Planning Model. The second stage is the Decision Model which examines criteria for the evaluation of individual requests of components. The Planning Model provides the basis for assessing the impact of releasing components as part of the decision process.

3.1 Planning Model[2]

To support the decision-making process, the Planning Model:

1. Identifies the station capabilities to meet future requirements.

2. Identifies threshold markers identifying significant change in Lennox's status.

---

[2] See Appendix C for Planning Requirements for Lennox GS

TABLE 3

PEAK RESERVE MARGIN (MW)
in JANUARY OF YEAR

Under Postulated Scenarios

Scenario \ Year	1985	1986	1987	1988	1989	1990	1991	1992	1993
S_1	3 057 (17%)	3 099 (17%)	3 886 (20%)	3 693 (19%)	4 369 (22%)	4 992 (25%)	4 613 (23%)	5 184 (25%)	5 615 (27%)
S_2	--	3 095 (17%)	3 882 (20%)	3 689 (19%)	4 365 (22%)	4 988 (25%)	4 609 (23%)	5 180 (25%)	5 611 (27%)
S_3	2 157 (12%)	2 199 (12%)	2 986 (16%)	2 793 (14%)	3 469 (18%)	4 092 (21%)	3 713 (18%)	4 284 (21%)	4 715 (23%)
S_4	--	--	2 822 (15%)	2 629 (14%)	3 305 (17%)	3 928 (20%)	3 549 (18%)	4 120 (20%)	4 551 (22%)
S_5	--	--	--	--	--	--	--	--	4 151 (20%)
S_6	993 (5%)	1 035 (6%)	1 822 (10%)	1 629 (8%)	2 305 (12%)	2 928 (15%)	2 252 (11%)	3 120 (15%)	3 551 (17%)
S_7	1 579 (9%)	714 (4%)	1 111 (6%)	527 (3%)	763 (4%)	945 (5%)	567 (3%)	697 (3%)	687 (3%)

Note: Figures in brackets indicate peak reserve margin as a percentage of peak planning firm load.

3. Assists in assessing the current status of the station's facilities and in identifying tradeoffs.

3.2 Decision Model

The Decision Model provides a method for the assessment of individual component requests. Its goals are to provide a framework to:

1. assess whether the requested component is available for release,

2. identity the practical alternatives,

3. evaluate the alternatives as to the costs and benefits, and

4. set conditions (if any) for the component's release.

The model uses information from a number of sources to evaluate requests. These are:

- The Request Document
- The status reports of the Lennox Facilities
- A component data base
- CTS technical and professional expertise
- Constraints and guidelines from the Planning Model

Figure 1 shows a schematic diagram for the Decision Model.

4. PROPOSED ORGANIZATION AND PROCEDURES

4.1 Component Data Base

There is a need for a data base on Lennox GS identifying the major systems and their prime components, along with their level of importance, necessary for the operation of the generating unit. The setup of the data base should be independent of the current status of Lennox's facilities.

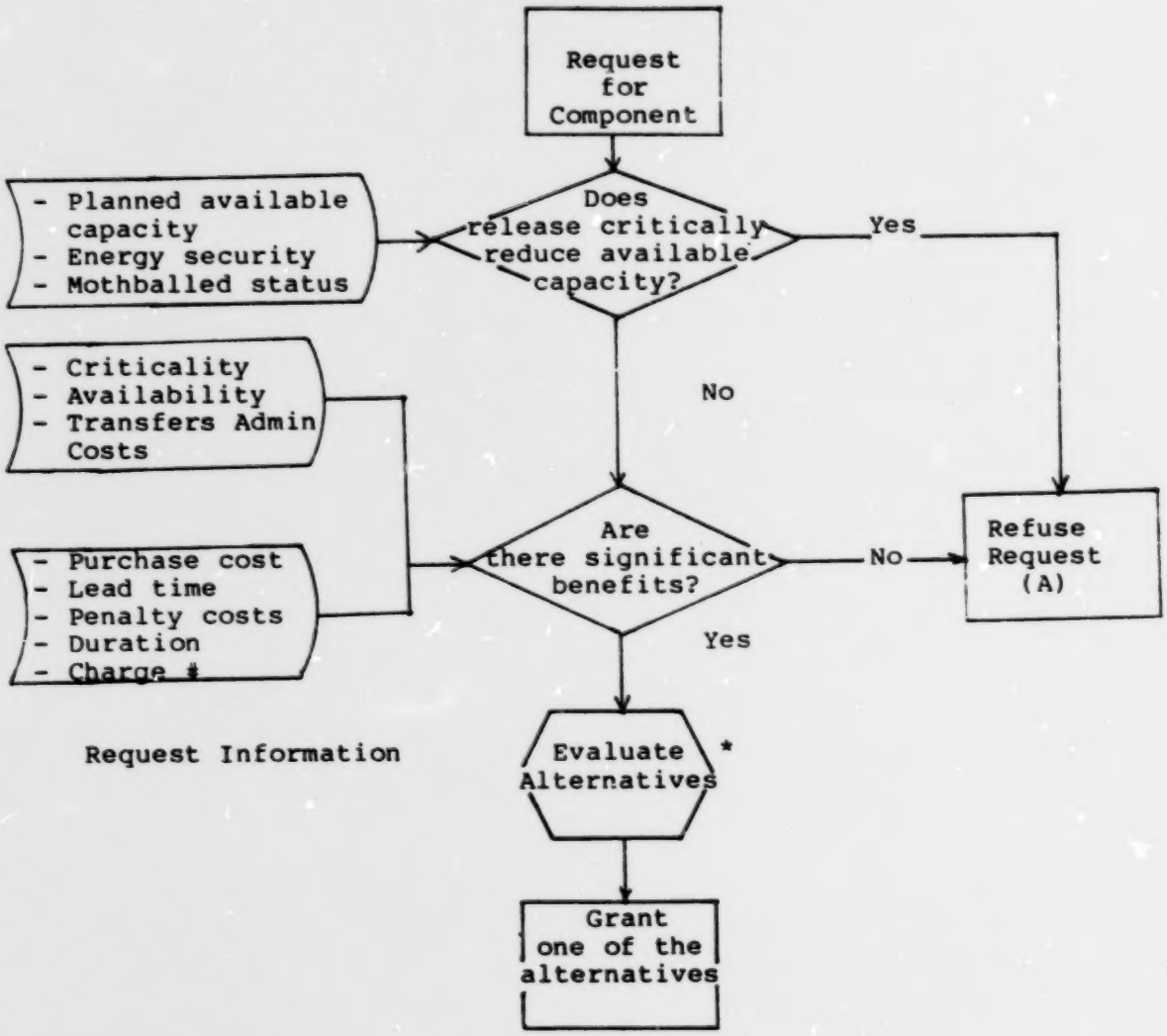
The data base should not be too large. Most of the information already exists in some form in the CTS record centre. The data base must be concise and easy to use for decision-making.

Requirements

The data base should cover the governing systems of each unit and identify major components. The effects of removal of

FIGURE 1

DECISION MODEL FOR COMPONENT REQUESTS



*Possible Alternatives are:

(B) Transfer unconditionally.
(C) Released component to be replaced by transferee at a later date.
(D) Exchange for a broken component.
(E) Lend for a fixed time period.

these components should be assessed and the criticality noted (eg, unit failure, derating, loss of reliability, and increased operating costs).

If a single component is part of more than one system or are used in parallel, the number commonly in service should be noted in relative terms (eg, 5,10,50,100).

This is meant to be a decision-making tool and will not serve as an inventory of capital equipment at Lennox. Not all components need to be listed nor would it be beneficial to do so.

4.2 Station Status File

To make valid decisions on Lennox and its equipment, it is necessary to keep an easily updated record of the station's status in CTS. Whereas the component data base should be stable, this file will need to be maintained. Its purpose is to provide a current picture of the station's capabilities. It should provide enough information to determine roughly how complete each unit is, and how much work (time, labour, and dollars) are needed to make each unit operable.

It is important for CTS to have a record of components that have been released or loaned from Lennox readily available. Furthermore, this list should be divided by units so that the status of each unit can be easily determined.

These documents should also separately identify the expected return rates for loaned components. (Note: If the component has in actual fact been released permanently, this should be formalized). A useful way to structure this information is to order the list by "Expected Return Date".

4.3 Component Request Documentation

Presently, there is no standard documentation for component requests. As such, information necessary for proper assessment of the request is lacking. Standardized request forms would help solve this problem and allow for more consistent information in decision-making.

A useful form should carry the following information:

1. General Information

- Who is requesting the component and for where?
- Date of the request
- Component being requested with its TSI listing
- Filing numbers for requesting station
- Types of request - transfer, loan or exchange

2. Reason for the request and its urgency.

3. Costs to be displaced by the Request.

4. Penalties or incurred costs if the request is denied (eg, energy replacement costs).

5. Component Requirement Date.

6. Estimated costs to repair damaged component (if applicable).

(See Appendix A for an Example of a Request Form).

4.4 Filing of Requests

Component requests should be filed in three places:

1. A copy of the request and following correspondence should be kept by the requesting station (or department).

2. Lennox GS should have a copy on file.

3. CTS should have a copy.

CTS could also consider keeping documentation of requests which are not granted. This aids in future evaluations and repeated requests. As well, it encourages greater consistency in the decision-making.

5. PROPOSED IMPLEMENTATION STRATEGY

5.1 The Planning Model

It is proposed that the implementation of the Planning Model should be done in three steps:

5.1.1 Determining the Requirements for Demothballing

This is done using the procedure described in Section 2 of this report. The output of this step would take the form of Tables 1, 2, and 3 or equivalent ones. This step can be performed by an informed professional or engineer in CTS in conjunction with PSOD staff.

5.1.2 Determining the Requirements for Retained Station Capacity

This step considers other factors governing station capacity in addition to the BES requirements and the energy security policy, such as fuel and operator availability, etc (This step can be performed by informed professionals or engineers in conjunction with CTS management and PSOD). The end product of this step will be a set of statements or recommendations that give a complete picture of the requirements and extent (MWs) for demothballing. Appendix C gives a sample of these requirements for Lennox TGS as of 1983.

5.1.3 Setting Up the Criteria for the Decision Model

This step takes the requirements for Demothballing and Retained Station Capacity and produces a set of working criteria or constraints regarding the preservation of the mothballed facilities at Lennox. This step would be carried out by CTS management at the managerial level or higher with necessary input from PSOD and System Planning. Broadly stated, the criteria should address the following:

1. The degree to which the facilities should be preserved from scavenging.

2. The capacity to be available given six months notice.

3. The capacity to be available given one year's notice.

4. A desired recommissioning time for a full return to service.

These decisions are influenced by:

1. Future demands for the facilities (from System Planning and Power System Operations [PSOD] Divisions).

2. Energy Security Considerations.

3. Demand for components by other stations.

5.1.4 Updating the Planning Model

Both the long and the short-term considerations are going to change over time and the Planning Model should reflect this. The model should be updated as necessary whenever there is a major shift in generation plans. Examples of these events would be decisions to retire one or more thermal generating stations, other large stations being mothballed, significant changes in the cost of oil or coal, major prolonged outages at a nuclear station etc. The method to update the Planning Model is the same as the one used to set up the model. The sources of information would also not be changed, but the most recent figures available should be used.

5.2 The Decision Model

It is proposed that the Decision Model should be implemented using the following three steps.

5.2.1 Setting Up Unit Capacity

The Decision Model uses the output of the Planning Model setup criteria for component availability. The first step is to specify planning constraints in terms of operational units at Lennox within a specified time frame, with a specified capacity. This can be performed by CTS management personnel with inputs from informed professionals. With these criteria in place, the maximum lead times for components that can be released from critical systems can also be determined.

5.2.2 Identifying the Critical Systems/Components

The next step is to further specify the retained capacity by identifying the major systems in each unit which should be kept intact and those which can be scavenged. This step can be performed by professional staff with input at the superintendent's level. The outcome will be a data base that can be used to quickly determine whether a requested component may or may not be released.

5.2.3 Assessing the Costs and Benefits

The third level of the decision model examines the benefits of releasing a specified component with respect to each of the viable alternatives. This is done according to the approved methods of financial evaluation within the corporation and the division. This step can be performed by professional staff.

Guidelines for performing financial evaluations are available from the Business Administration Department of CTS. All costs and benefits should be represented in present value dollars. After evaluating each of the likely alternatives against the costs of refusing the request, the most promising alternative can be chosen.

The following costs/benefits should be examined where they apply:

1. Present purchase cost of the component: order, setup, and transportation costs should be included.

2. Book value of the requested component.

3. Labour costs to remove the requested component and prepare it for shipping (include administrative overhead).

4. Transportation costs to ship component from Lennox.

5. Penalty costs due to lost generation and the cost of replacing power if the component must be ordered.

6. Replacement costs to reorder the component at a later date.

Net benefits = [costs to refuse requests]
- [costs to grant request][3]

= [(1) + (5)] - [(2) + (3) + (4) + (6)]

6. CONCLUSIONS

For an effective and efficient implementation of the proposed method for utilizing components at mothballed facilities, the following are considered essential.

1. The lines of authority should be clarified on all levels. For future mothballed facilities, these responsibilities should be established early and the transfer of authority outlined.

2. The required retained capabilities for Lennox and other mothballed stations should be explicitly stated.

---

[3] All figures are present values (use current escalation discount tables/10,11/.

3. A data base should be set up identifying the major systems/ subsystems at Lennox and their criticality with respect to a unit's operation.

4. A file documenting all capital equipment released from Lennox be kept on hand at CTS.

5. Component request documentation should be standardized. A request form should be created identifying all the required information and authorization.

6. Component transfers along with request documentation should be filed by the transferor (Lennox), the transferee and by CTS.

7. The financial benefits/costs be evaluated using "The Present Value" basis following the division's financial evaluation guidelines.[4]

ACKNOWLEDGEMENTS

This project was undertaken by the Operations Research Department at the request of Central Thermal Services. The authors wish to thank the staff of Central Thermal Services for providing necessary information and assistance. They also wish to thank Mr. M.J. Agrell of Systems Planning Division, Mr. K.L. Rawson of Power System Operations Division and Mr. M. Milicev, Dr. C. Gordon and Mr. B. Collingwood of Design and Development Division for their valuable input.

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[4] Based on Corporate Financial Evaluation Procedures/11/.

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APPENDIX A

SAMPLE REQUEST FORM

Component Request Form

Requested by:	Loc/Ext	Date
System _____ TSI _____	File No _____ X CTS _____ X Lennox _____	
Request Type	Transfer _____ Loan _____ Duration _____ Exchange _____	
Equipment Description and Reason for Request		
Purchase Cost Order & Setup Costs Total Lead Time to Order Equipment: Date Required Penalities if Unavailable Submitted by Approved by		
Action Taken		Approved by Date
Transport and Adminstration Costs		
Conditions		
Follow-Up		

December 1983
Operations Research Department

APPENDIX B

STEP BY STEP REQUEST EVALUATION PROCEDURE

A general procedure for the evaluation of components requested from mothballed facilities.

1. Receive Request Document: Check that all the required information and authorization are present.

2. Evaluate Impact of Granting Request: Determine if the release of the desired component affects the available retained capacity of the mothballed station. Use the component data base (if one exists) to check criticality. Then determine whether this affects the PRESENT capabilities of the station. If it does NOT, go to Step (4).

3. Determine if the Component Can be Released: Check to see if the station's retained capacity requirements (see Section 5.2.1) are not violated by granting the request. If they are, refuse the request.

4. Identify Alternatives: Common ones are: release the component, exchange for broken component on loan, etc

5. Evaluate Promising Alternatives: Assess the cost benefits of realistic alternatives (see Section 5.2.3) using present values.

6. Choose Best Alternative

7. Authorize Release: Charge numbers for transfer costs should be set up prior to authorization. Also conditions for repairs to components to be exchanged or the duration of loans should be in writing with necessary approvals.

APPENDIX C

PLANNING REQUIREMENTS FOR LENNOX GS AS OF DECEMBER 1983

This is an example of the process described in Section 3.1. It is based on information available from PSOD and System Planning in the fall of 1983/1,3,8/. Both PSOD and System Planning should be consulted for current information.

Planning Horizon

Planning considerations for the return to service of Lennox GS are based on two time frames. The first examines the near term: a five-year span from 1984-1988. The second looks at the remaining life of the station: the next twenty years.

Return to Service for Contingencies 1984-1985

- No planned return to service is anticipated for this time period. Any return to service would be a result of a contingency situation.
- Lennox's capabilities and lead time to service should match System Planning and PSOD's expectations of Lennox's ability to assist in contingencies.
- The Hearn and Keith units are other alternatives to provide lost power.
- Presently, Units 1 and 2 are complete and could be demothballed on short notice. Unit 4 is relatively intact. It may presently not be possible to return Unit 3 within one year/9/.
- Short-term capabilities should be in line with CTS' ability to assure fuel supply to the station.
- It has been assumed that the Hearn and Lakeview Generating Stations will not be retired within the time frame.
- It is assumed that the severity and duration of contingencies can be assessed quickly.

There are still unresolved issues to be dealt with if well-defined short-term capabilities are to be set and supported. A major factor is the cost of recommissioning the facilities and the lead times. Then, if the cost of replacement power resulting from a contingency is known and the duration could be estimated, one can determine whether it is worthwile to

demothball Lennox or not. The role of Lennox in any contingency could also be better defined.

Planned Return to Service (20-Year Horizon)

The long-term requirements for Lennox are based on the premise that the station was mothballed with the intention of being returned to service in the mid-1990's at full capacity. A lead time of 2-3 years is expected to be sufficient to make the facilities operable and to provide and/or train the necessary manpower.

At the present time it is not expected that Lennox will be needed to meet demand prior to mid-1990's. Then all the nuclear units presently planned or under construction will be in service and to date no thermal generating units after Darlington have been planned.

Originally, it was planned that Lennox would return to service as an oil-fired station but while probable, it is still uncertain. It is expected that the station would be utilized as a peaking facility.